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# THE STEWART - CASSIAR HIGHWAY

# SOCIAL BENEFIT COST ANALYSIS.

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Commerce 545

Christopher E. Graham.

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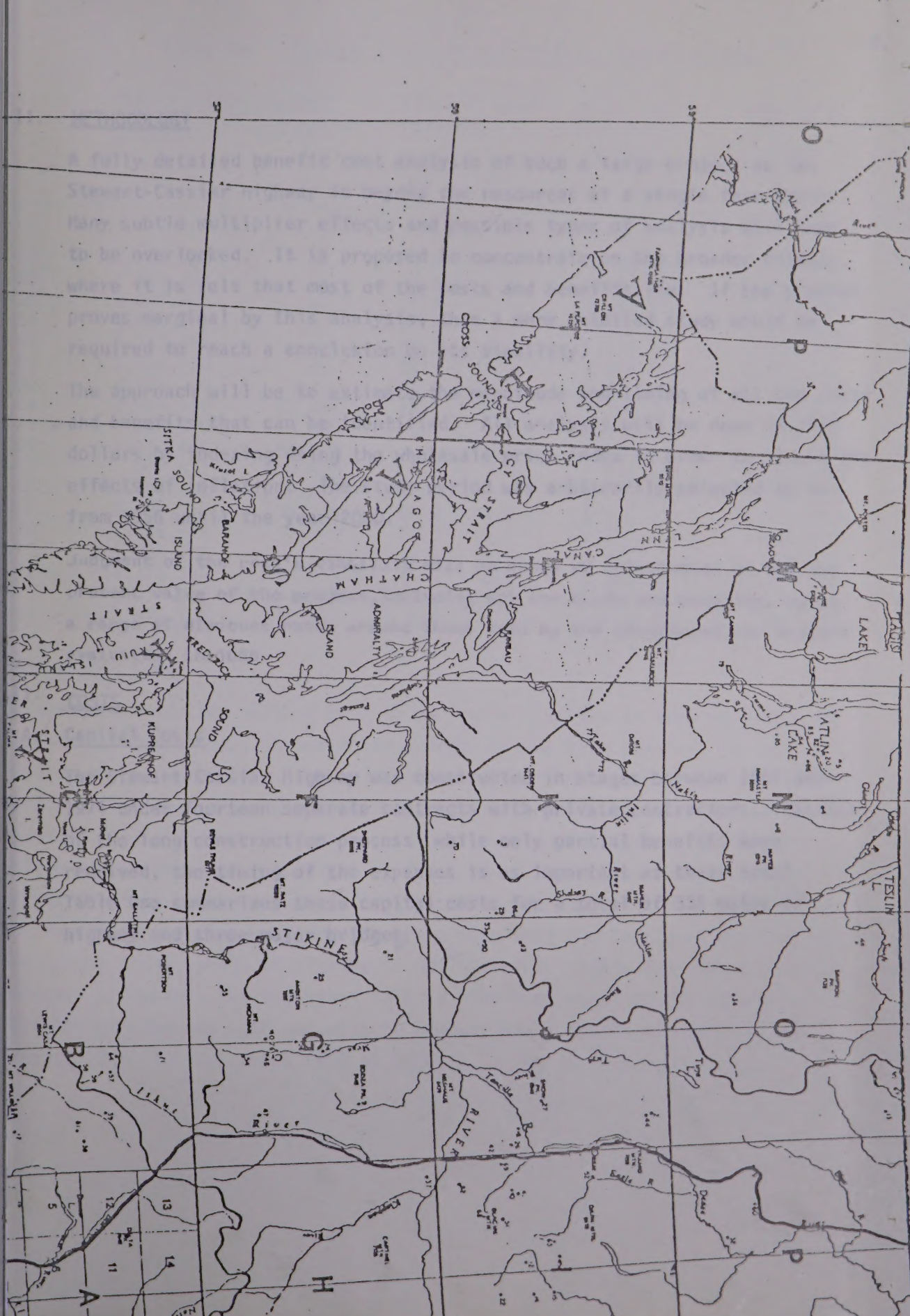
INTRODUCTION.

The Stewart-Cassiar Highway was commenced in 1955 as a low quality mining road to give access from Stewart at the head of Portland Inlet, to Watson Lake on the Alaska Highway - a distance of about 400 miles. Its location in north west B.C. is shown in Figure One. The provincial government suggested that the road would open up a "treasure house of minerals and timber resources.[1] It was scheduled for completion in 1954.

Studies at that time showed that the road would cost about $15 million. The federal government was to contribute $7.5 million under the "Roads to Resources" program. By 1963, $15 million had been spent and only 191 miles of road had been completed. Federal assistance was terminated, and Premier Bennett announced that B.C. would finish the highway alone. It was finally completed in 1974 at a total cost of $30.5 million .

No study was done to justify the decision to proceed with the road. Heaver, in his thesis on transportation in Northern British Columbia concluded that "it is extremely unfortunate that a full economic study of the expensive resource development from Stewart to Cassiar was not carried out. In fact, the planning of this road is an unfortunate example of the political process."[2]

Thus, a social benefit cost analysis of this road would be extremely interesting. There is still strong interest in resource development roads in Canada. An ex poste evaluation of such a project should prove valuable to decision makers seeking to encourage resource development.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L.

## II. METHODOLOGY

A fully detailed benefit cost analysis of such a large project as the Stewart-Cassiar Highway is beyond the resources of a single term paper. Many subtle multiplier effects and possible types of analysis will have to be overlooked. It is proposed to concentrate on the broader effects where it is felt that most of the costs and benefits lie. If the project proves marginal by this analysis, then a more detailed study would be required to reach a conclusion on its viability.

The approach will be to estimate the magnitude and timing of all the costs and benefits that can be identified. All analysis will be done in 1956 dollars by indexing using the wholesale price index in order to remove the effects of inflation. The study period was arbitrarily selected to be from 1956 until the year 2000.

Judgment of the road's viability will be based on calculation of the net present value of the project, including all its costs and benefits, using a range of discount rates around those used by the government for project evaluation in 1956

## II. COSTS

### A. Capital Costs.

The Stewart-Cassiar Highway was constructed in stages between 1956 and 1974 under fourteen separate contracts with private contractors. Because of the long construction process while only partial benefits were received, the timing of the expenses is as important as their total. Table One summarizes these capital costs for a total of 335 miles of highway and three major bridges.

Table One - Capital Costs of the Stewart-Cassiar Highway.[3]

| | Construction Expense | | Miles of Road Completed. | | Total Cost (current dollars) | Total Cost (1956 dollars) |
|---|---|---|---|---|---|---|
| | Highway | Bridges | North End | South End | | |
| -57 | 33,700 | - | 1.5 | - | 33,700 | 33,700 |
| -58 | 461,377 | - | 7.6 | - | 461,377 | 456,045 |
| -59 | 1,047,830 | - | 17.3 | - | 1,047,830 | 1,023,892 |
| -60 | 1,566,670 | - | 25.8 | - | 1,566,670 | 1,513,589 |
| -61 | 2,315,840 | - | 34.1 | 3.1 | 2,315,720 | 2,216,777 |
| -62 | 2,266,720 | - | 18.7 | 18.9 | 1,964,455 | 2,048,885 |
| -63 | 2,176,711 | - | 22.2 | 13.5 | 1,987,018 | 1,848,552 |
| -64 | 1,964,455 | 22,562 | 18.1 | 10.8 | 298,511 | 1,829,617 |
| -65 | 297,550 | 961 | 1.6 | 3.5 | 1,172,460 | 262,767 |
| -66 | 1,110,894 | 61,566 | - | 2.9 | 1,529,414 | 983,319 |
| -67 | 874,811 | 654,603 | 4.2 | 1.0 | 974,170 | 1,203,326 |
| -68 | 704,052 | 210,118 | 4.5 | - | 2,678,694 | 724,659 |
| -69 | 2,639,579 | 39,115 | 10.0 | 24.0 | 1,627,404 | 1,972,340 |
| -70 | 1,625,725 | 1,679 | 10.8 | 10.7 | 1,047,717 | 1,143,679 |
| -71 | 1,046,987 | 730 | 12.5 | 4.4 | 1,047,717 | 720,161 |
| -72 | 4,176,245 | 48,412 | 17.5 | 8.5 | 4,224.657 | 2,734,114 |
| -73 | 3,074,078 | 1,192,998 | 12.0 | 11.0 | 4,267,076 | 2,557,527 |
| -74 | 1,076,509 | 102,187 | 5.0 | - | 1,178,676 | 645,972 |

Maintenance Costs.

Maintenance costs are defined here as all costs incurred in keeping completed sections of the highway in operation. They include road repairs, bridge repairs and snow removal. The maintenance costs of the Stewart Cassiar Highway were not reported separately from the costs for the highway district containing the road (Atlin Highway District). It was assumed maintenance cost is approximately proportional to the length of the highway. Then the cost for the Stewart-Cassiar section of highway could be separated from the total reported maintenance for the Atlin District by using the proportion that the length of the highway was of the total length of highway in the district. Table Two summarizes the results. Forecasts for the years 1976 to 2000 were based on the assumption that the maintenance cost per mile of highway would remain constant at the average level for the years 1970 to 1975.

Table Two - Maintenance Costs For the Stewart-Cassiar Highway.[4]

| Year | Maintenance Expense- Total Atlin District | Total Miles of Road | Miles of S/C Highway | Maintenance Expense- S/C Highway | Indexed Expense to 1956 |
|---|---|---|---|---|---|
| 1955-56 | $190,500 | 160 | 1.5 | $1,780 | $1,780 |
| 1956-57 | 238,000 | 169 | 9.1 | 12,820 | 12,820 |
| 1957-58 | 201,000 | 177 | 17.3 | 19,650 | 19,400 |
| 1958-59 | 164,600 | 186 | 26.4 | 23,360 | 22,800 |
| 1959-60 | 136,600 | 212 | 52.2 | 33,630 | 32,200 |
| 1960-61 | 141,200 | 249 | 89.4 | 50,700 | 48,530 |
| 1961-62 | 128,700 | 287 | 127.0 | 56,600 | 53,260 |
| 1962-63 | 164,600 | 302 | 162.7 | 87,970 | 82,700 |
| 1963-64 | 212,000 | 352 | 191.6 | 115,400 | 106,200 |
| 1964-65 | 200,000 | 357 | 196.7 | 109,000 | 95,900 |
| 1965-66 | 201,000 | 360 | 199.6 | 111,100 | 93,200 |
| 1966-67 | 287,100 | 384 | 204.8 | 152,000 | 120,200 |
| 1967-68 | 293,700 | 395 | 209.3 | 154,500 | 115,400 |
| 1968-69 | 286,400 | 443 | 243.3 | 220,000 | 162,000 |
| 1969-70 | 319,000 | 465 | 264.8 | 181,000 | 127,300 |
| 1970-71 | 332,500 | 482 | 281.7 | 193,000 | 132,600 |
| 1971-72 | 465,200 | 508 | 307.7 | 281,000 | 181,800 |
| 1972-73 | 532,500 | 536 | 330.7 | 327,500 | 196,200 |
| 1973-74 | 651,800 | 541 | 335.7 | 403,100 | 221,800 |
| 1974-75 | $1,018,700 | 541 | 335.7 | $630,000 * | $327,500 * |
| 1975-76 | | | | | ($222,000 |
| " | | | | | ( " |
| " | | | | forecast | ( " |
| " | | | | | ( " |
| 1999-2000 | | | | | ($222,000 |

* Heavy snow year.

## BENEFITS

The Stewart-Cassiar Highway was funded by the Department of Mines and Petroleum Resources. Its main purpose was to open up the north-west part of British Columbia to mining exploration, and to reduce the transportation costs of existing mines. The decision to proceed with the project was based on these goals.

Other bonus benefits that should also be considered are: benefits to forestry; benefits to through-traffic; benefits to recreational traffic; and benefits through improved access to the communities in the area.

The North-West part of B.C. served by the highway is very remote. At best, the Stewart-Cassiar is poor in comparison to other highways in the province; even in comparison to the gravel-surfaced Alaska Highway so the major benefits from the Highway should be to mining or forestry. Also, no traffic counts are available for the highway so the benefits to through traffic and recreational traffic would be difficult to quantify. Thus, the following section will concentrate on estimating the benefits to mining and forestry. It can be assured that at least a minimum value for the benefits will be obtained.

### Benefits to Mining.

These benefits fall into two categories: Reductions in transportation costs to producing mines and reductions in cost to prospecting and exploration. To study the effects of the highway on these operations, a section of north-west B.C. was isolated for anlaysis: the land west of $138^{0}$ longitude and north of $56^{0}$ latitude. The highway lies at least 60 miles within this region so the region should contain all the effects of the road on mining.

Within this area there were only two operating mines in 1956 - the Cassiar asbestos mine and the Granduc mine at Stewart. No new mines have appeared up to the present (1976).

The Granduc Mine receives no benefit from the highway as the mine is directly on tidewater at Stewart, and the mineral concentrates and supplies travel cheaply by ship.

It was expected that the Cassiar mine would use the highway to truck its asbestos fibres to the port at Stewart. In 1956 the asbestos was being trucked north from Cassiar to Whitehorse, and then by rail to the

port at Skagway, Alaska. When the highway link from Cassiar to Stewart was finally completed in 1974, Cassiar Asbestos Ltd. continued to ship through Skagway, making no use of the new highway.

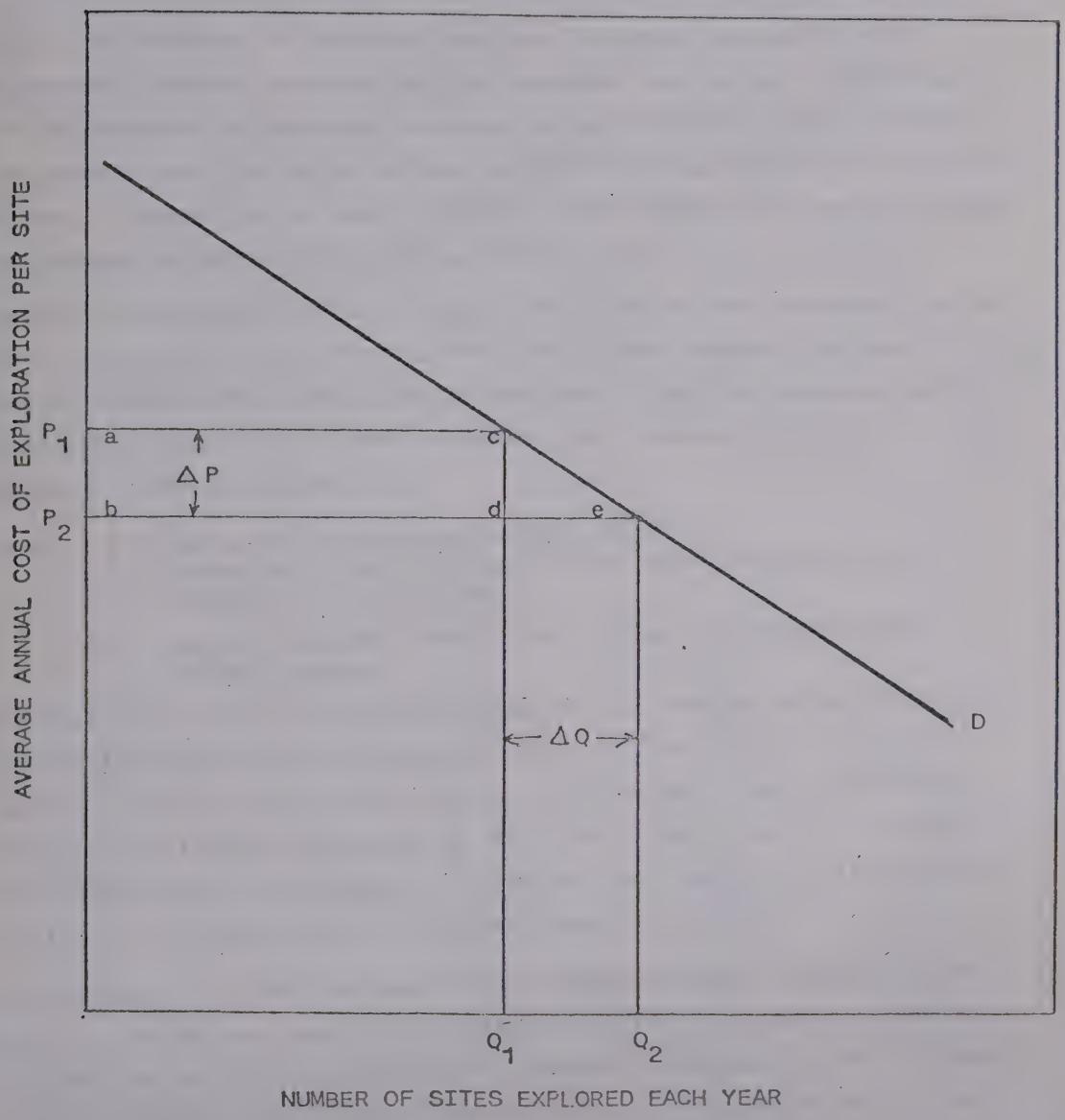
Thus the expected benefit of the Stewart-Cassiar to existing producing mines failed to materialize and cannot be counted as a benefit in this analysis.

Although no new mines have appeared in the study area, there has been considerable exploration activity. The highway would affect this exploration in two ways: It would reduce the cost of exploration that would have occurred in the absence of the highway, and it would encourage exploration that would not have occurred otherwise.

It might be questioned whether increased exploration should be taken as a benefit when no producting mines resulted; however, this could not have been known when the decision to build the road was made: The benefit of increased exploration is the increased probability of finding an ore body. Assuming that the amount of exploration increases until its marginal benefit equals its marginal cost, then expenditure on exploration should equal the net present value to the exploration companies of the probability of an ore body being found in the future. Possibly the social benefit of exploration is different from the private benefit of the companies making the exploration decision due to externalities or to differences in risk levels. This will be considered in a later section of this paper.

A theoretical model was developed to aid in measuring the benefits of the road to exploration. Figure Two shows the supply and demand curves relating P, the exploration cost per exploration site per year, to Q, the number of prospects worth exploring at a given cost level for exploration. The demand curve, D, will depend on exogenous factors in the world mineral market and on the probability of finding minerals, and is assumed fixed.

FIGURE TWO – DEMAND FOR DOMESTIC EXPLORATION
SHOWING BENEFIT DUE TO EXPLORATION
COST REDUCTION



As shown on the diagram, a reduction in transportation costs reduces exploration costs from $P_1$ to $P_2$, causing an increase in exploration in the area influenced by the road from $Q_1$ to $Q_2$. The cost reduction causes an increase in consumer surplus to mining companies which "purchase" mineral exploration from mineral development companies. On the diagram the consumer surplus is represented by area a,b,d,e,c. The benefit will be split between sites that would have been explored anyway, area a,b,c,d, and sites for which exploration was encouraged by reduced transportation costs, area c,d,e.

Assuming that the increase in exploration was a true increase, rather than a transfer of exploration that would have occurred anyway but now occurs in the area influenced by the road. That is, assuming that $\Delta Q$ measures the net exploration increase, the consumer surplus will be:

surplus = $\frac{1}{2} * S * \Delta Q + \Delta S * Q$

Where S = reduction in transportation costs
Q = number of sites that would have been explored in the absence of the highway.

$\Delta Q$ = number that were encouraged to be explored because of the highway.

Estimation of $\Delta S$, the average reduction in transportation costs to exploration due to the highway was done by several interviews with mining engineers. With road access to a region, approximately 5% of total exploration expenses go to transportation, while if access to the region must be gained by floatplane or riverbarge, the transport costs rise to about 11% of total exploration costs.

To estimate $\Delta Q$, the increase in exploration due to the road, a regression model was used to separate the effects on the quantity of exploration of mineral potential, distance from the highway, distance from tidewater, and distance from airbases. The region was divided into 136 zones, and for all exploration in 1971 and 1972 the number of exploration sites per zone was regressed against the characteristics of the zones according to the above criteria. The regression produced excellent results. Mineral potential was a highly significant predictor of exploration activity. However, proximity to the road was also significant at the 1% level and proximity to an air-

base was significant at the 10% level. The other independent variables were notsignificant. Analysis of the results showed that the highway resulted in a 20% increase in total exploration activity in the study region.

To estimate Q, the number of exploration sites each year using the highway for access, information on exploration activity each year was available in the Annual Reports of the British Columbia Minister of Mines: The following table describes the information:

Table Three: Mineral Exploration in Region of the Stewart-Cassiar Highway[6].

| Year | Total Exploration Sites in Study Region. | Number of Exploration Sites Using Road for Access. | Miles of Road Completed. | Estimated Increase in Exploration due t Presence of Roa |
|---|---|---|---|---|
| 1954 | 5 | 0 | - | 0 |
| 1955 | 10 | 0 | - | 0 |
| 1956 | 10 | 0 | 1.5 | 0 |
| 1957 | 5 | 0 | 7.6 | 0 |
| 1958 | 3 | 0 | 17.3 | 0 |
| 1959 | 5 | 1 | 26.4 | 0 |
| 1960 | 11 | 1 | 52.2 | 1 |
| 1961 | 10 | 2 | 89.4 | 1 |
| 1962 | 11 | 1 | 127.0 | 1 |
| 1963 | 18 | 3 | 162.7 | 2 |
| 1964 | 29 | 6 | 191.6 | 3 |
| 1965 | 54 | 11 | 196.7 | 6 |
| 1966 | 33 | 7 | 199.6 | 4 |
| 1967 | 39 | 8 | 204.8 | 5 |
| 1968 | 34 | 9 | 209.3 | 4 |
| 1969 | 39 | 9 | 243.3 | 6 |
| 1970 | 65 | 13 | 264.8 | 10 |
| 1971 | 67 | 28 | 281.7 | 11 |
| 1972 | 86 | 33 | 307.7 | 16 |
| 1973 | 44 | 14 * | 330.7 | 9 |
| 1974 | 38 | 13 * | 335.7 | 8 |

* Decline in exploration in 1973 and 1974 due to weakness in World mineral markets, and N.D.P. mine taxation policies.

The average exploration expenditure per site per year over the period from 1968 to 1976 was $101,000. The average saving in transport costs due to the road was 6% of the total exploration expense per site (11% - 5% from above). Thus the benefit to an exploration project that would have explored even in the absence of the road is approximately $6060. The benefit to an exploration project that was induced to explore from the presence of the highway is approximately one half of this, or $3030. These are in current dollars in 1971 and thus must be indexed to 1956. When this is done the benefits are reduced to $3,921 and $1,961. These indexed benefits per site are assumed to remain constant from the year 1956 to 2000. Although technological changes may make this assumption invalid, it was necessary for simplicity. Table Four summarizes the net benefit from the highway to exploration.

Table Four - Net Benefit of Stewart-Cassiar Highway to Mineral Explorations.

| Year | Basic[8] Exploration | Increased[8] Exploration | Net Benefit (1956 Dollars) |
|---|---|---|---|
| 1956 | 0 | 0 | |
| 1967 | 0 | 0 | |
| 1958 | 0 | 0 | |
| 1959 | 1 | 0 | 3,921 |
| 1960 | 0 | 1 | 1,961 |
| 1961 | 1 | 1 | 5,882 |
| 1962 | 0 | 1 | 1,961 |
| 1963 | 1 | 2 | 7,842 |
| 1964 | 3 | 3 | 17,646 |
| 1965 | 5 | 6 | 31,370 |
| 1966 | 3 | 4 | 19,606 |
| 1967 | 3 | 5 | 21,567 |
| 1968 | 5 | 4 | 27,448 |
| 1969 | 3 | 6 | 23,528 |
| 1970 | 3 | 10 | 31,372 |
| 1971 | 17 | 11 | 88,277 |
| 1972 | 17 | 16 | 98,032 |
| 1973 | 5 | 9 | 37,253 |
| 1974 | 5 | 8 | 35,292 |
| 1975 | 9 | 11 | 56,859 |
| 1976 | 9 | 11 | 56,859 |
| " | " | " | " |
| " | " | " | ". |
| " | " | " | " |
| 2000 | 9 | 11 | 56,859 |

Note that considerably more research will be required to establish exactly how exploration would be expected to change in the future. Here it is assumed that the effect of the area being "mined out" will be counterbalanced by the

increase in mineral demand and the reduction in higher grade supplies, to result in little net change in the average annual number of sites using the road for exploration.

One additional form of benefit mentioned above but not yet considered in detail is the benefit to society of the increased probability of finding a mine due to the increased exploration activity shown in Table Four. It has been argued that society, in making a project decision, should not apply a risk premium to its discount rate[9]. The argument is that since society undertakes so many projects, the standard deviation of the average return will be much less than the standard deviation of any single project, thus eliminating the risk of all but the largest projects.

However, private exploration companies do perceive the high risk of exploration and so will certainly reject projects that would have been profitable from the point of view of society. This is the basis for the many programs designed to encourage mineral exploration, such as tax incentives, mineral bounties, geological surveys, and resource roads such as the Stewart-Cassiar Highway: to increase exploration activity to the socially optimal level.

Therefore, a rough estimate is needed of the increase in the probability that a mine will be found due to the increased exploration activity caused by the road. A study of the mineral industry in Canada revealed that an average of 18 million dollars worth of exploration activity was required for the discovery of one exploitable ore body. Thereafter, mine development took two years and cost 2 8 million dollars per year. Finally, the average mine produced before-tax profits of 2 5 million dollars per year for 14 years.[10]

These figures are in 1975 dollars. When indexed to 1956 dollars, it is found that $9,358,000 of exploration expenses were incurred in finding an ore body; two years of development at $14,556,000 per year was required to develop the ore into an operating mine; and when in production the mine showed $13,000,000 per year in before tax profits for 14 years.

To include the benefits of increased exploration from the probability of finding developable ore bodies the following method will be used. It will be assumed that the induced exploration is part of the project, and that the total net costs and benefits of the exploration contribute

Table Five - Costs and Benefits of the Development of New Mines Induced By the Stewart-Cassiar Highway

| Year | Estimated Exploration Increase Due to Road | Cumulative Exploration Expenditure ($1000) | Annual Exploration Cost ($1000) | Annual Mine Development Cost ($1000) | Gross Mine Operating Profit ($1000) | Net Benefit |
|---|---|---|---|---|---|---|
| 1956 | | - | - | - | - | - |
| 1957 | - | - | - | - | - | - |
| 1958 | - | - | - | - | - | - |
| 1959 | - | - | - | - | - | - |
| 1960 | 1 | 65 | 61 | - | - | -61 |
| 1961 | 1 | 130 | 61 | - | - | -61 |
| 1962 | 1 | 196 | 61 | - | - | -61 |
| 1963 | 2 | 326 | 122 | - | - | -122 |
| 1964 | 3 | 522 | 183 | - | - | -183 |
| 1965 | 6 | 915 | 366 | - | - | -366 |
| 1966 | 4 | 1,176 | 244 | - | - | -244 |
| 1967 | 5 | 1,503 | 305 | - | - | -305 |
| 1968 | 4 | 1,764 | 244 | - | - | -244 |
| 1969 | 6 | 2,157 | 366 | - | - | -366 |
| 1970 | 10 | 2,810 | 610 | - | - | -610 |
| 1971 | 11 | 3,529 | 671 | - | - | -671 |
| 1972 | 16 | 4,575 | 976 | - | - | -976 |
| 1973 | 9 | 5,163 | 549 | - | - | -549 |
| 1974 | 8 | 5 686 | 488 | - | - | -488 |
| 1975 | 11 | 6,275 | 671 | - | - | -671 |
| 1976 | " | 7,134 | " | - | - | -671 |
| 1977 | " | 7,843 | " | - | - | -671 |
| 1978 | " | 8,562 | " | - | - | -671 |
| 1979 | " | * 9,281 | " | - | - | -671 |
| 1980 | " | 719 | " | 14,500 | - | -15,171 |
| 1981 | " | 1,438 | " | 14,500 | - | -15,171 |
| 1982 | " | 2,157 | " | - | 13,000 | 12,329 |
| 1983 | " | 2,816 | " | - | 13,000 | 12,329 |
| 1984 | " | 3,595 | " | - | " | 12,329 |
| 1985 | " | 4,314 | " | - | " | 12,329 |
| 1986 | " | 5,033 | " | - | " | 12,329 |
| 1987 | " | 5,752 | " | - | " | 12,329 |
| 1988 | " | 6,471 | " | - | " | 12,329 |
| 1989 | " | 7,190 | " | - | " | 12,329 |
| 1990 | " | 7,909 | " | - | " | 12,329 |
| 1991 | " | 8,682 | " | - | " | 12,329 |
| 1992 | " | * 9,347 | ** | 14,500 | " | -1,500 |
| 1993 | " | ** | ** | 14,500 | " | -1,500 |
| 1994 | " | ** | ** | - | 26,000 | 26,000 |
| 1995 | " | ** | ** | - | 26,000 | 26,000 |
| 1996 | " | ** | ** | - | " | 26,000 |
| 1997 | " | ** | ** | - | " | 26,000 |
| 1998 | " | ** | ** | - | " | 26,000 |
| 1999 | " | ** | ** | - | " | 26,000 |
| 2000 | " | ** | ** | - | " | 26,000 |

* - Ore body assumed to be found.
** - The benefits from these expenditures will not appear in the evaluation period so the expenditures are excluded.

to the costs and benefits of the highway project. For simplicity, it will be assumed that when the cumulative amount of induced exploration equals $9,358,000 then a mine will be found and immediately developed and put into production.

Table Five summarizes the results. The cumulative expenditure on induced exploration is based on an average expenditure per mineral prospect examined, per year of $101,000 in 1971 dollars, or $65,365 in 1956 dollars. The costs of exploration or development are based on the same figure of $65,365, less the saving in the cost of exploration due to the road.

B. Benefits to Forestry.

Most of the area served by the highway has no forestry potential. The maximum distance that logs can be profitably shipped by truck along a trunk road is about 75 miles.[12] Thus, the Bell-Irving Sustained Yield Unit will be the only one affected by the highway. There was virtually no production in this area before it was accessible by the highway, and even after completion of the highway, up to the year 1975, no production occurred due to the slack demand for forest products. However, it must be assumed that the potential of this unit will be exploited in the future, and this will be a benefit from the highway.

The Bell-Irving Unit contains 326,576 acres of productive land.[13] The average sustained yield from the Prince Rupert area is 0.31 cunits[14] per acre, per year, indicating a potential sustained yield of 101,238 cunits per year from the Bell-Irving Unit. No forecast is available of when this full potential will be reached. It is reasonable to expect, however, that this timber will begin to be exploited when the demand for forest products recovers. The first signs of recovery can be seen in 1977, and it will be assumed here that it will take five years for the area to each full production. A linear increase in production will be assumed from 1977 to 1982, thereafter remaining constant at 101,238 units per year until the end of the evaluation period.

The net dollar social benefits from this production can be estimated from the amount that is paid by the buyers of the production, less the cost of production. Gross revenue will go to: return on the forest producer's investment, wages and salaries, other production costs, corporate taxes, and stumpage rates. Assuming monopolistic profits are not earned, then net benefits to society will be measured by the sum of corporate taxes and stumpage, less the cost of administering the B.C.Forest Service. The calculations are as follows, using average figures, over the years 1971 to 1976:[15]

| | |
|---|---|
| Average Gross Annual Forest Revenue to Province | $132,710,000 |
| Federal and Provincial Income Taxes | $ 64,800,000 |
| | $197,510,000 |
| Less - Expenses for operating B.C.Forest Service | $ 53,200,000 |
| Average Net Annual Benefit | $144,310,000 |

This benefit is derived from an average harvest of 205,800,000 cunits
Therefore, net benefit per cunit harvested - $0.70

Applying the forecast production and indexing to 1956 dollars, the following flow of benefits is the result.

Table Six - Benefits from Increased Forest Products Production.

| Year | Net Benefit (1973 Dollars) | Net Benefit (1956 Dollars) |
|---|---|---|
| 1977 | 14,160 | 7,800 |
| 1978 | 28,320 | 15,600 |
| 1979 | 42,480 | 23,300 |
| 1980 | 56,640 | 31,100 |
| 1981 | 70,800 | 38,900 |
| 1982 | 70,800 | 38,900 |
| " | " | " |
| " | " | " |
| " | " | " |
| " | increasing at | " |
| " | the rate of | " |
| 2000 | inflation | 38,900 |

## V. SUMMARY AND CONCLUSIONS

Table Seven summarizes all the costs and benefits derived above.

Table Seven- Summary of Costs and Benefits of Stewart-Cassiar Highway in Thousands of 1956 Dollars

| Year | COSTS | | | | BENEFITS | | | | Net Benefits |
|---|---|---|---|---|---|---|---|---|---|
| | Capital | Main-tenance | Induced Explor-ation | Total Costs | To Explor-ation | From New Mines | To Forestry | Total Benefits | |
| 1956-57 | 34 | 2 | - | 36 | | | | | |
| 1957-58 | 456 | 13 | - | 469 | | | | | |
| 1958-59 | 1024 | 19 | - | 1043 | | | | | |
| 1959-60 | 1514 | 23 | - | 1537 | | | | | |
| 1960-61 | 2217 | 32 | 61 | 2310 | | | | | |
| 1961-62 | 2048 | 49 | 61 | 2158 | 2 | - | - | 2 | -2156 |
| 1962-63 | 1849 | 53 | 61 | 1963 | 6 | - | - | 6 | -1957 |
| 1963-64 | 1830 | 83 | 122 | 2035 | 2 | - | - | 2 | -2033 |
| 1964-65 | 263 | 106 | 183 | 289 | 8 | - | - | 8 | - 281 |
| 1965-66 | 983 | 96 | 366 | 1445 | 18 | - | - | 18 | -1427 |
| 1966-67 | 1023 | 93 | 244 | 1540 | 31 | - | - | 31 | -1509 |
| 1967-68 | 725 | 120 | 305 | 1150 | 20 | - | - | 20 | -1130 |
| 1968-69 | 1972 | 115 | 244 | 2331 | 22 | - | - | 22 | -2309 |
| 1969-70 | 1144 | 162 | 366 | 1672 | 27 | - | - | 27 | -1645 |
| 1970-71 | 720 | 127 | 610 | 1457 | 24 | - | - | 24 | -1433 |
| 1971-72 | 2734 | 133 | 671 | 3538 | 31 | - | - | 31 | -3507 |
| 1972-73 | 2558 | 182 | 978 | 3716 | 88 | - | - | 88 | -3628 |
| 1973-74 | 646 | 196 | 549 | 1391 | 98 | - | - | 98 | -1293 |
| 1974-75 | - | 222 | 488 | 710 | 37 | - | - | 37 | -673 |
| 1975-76 | - | 328 | 671 | 999 | 35 | - | - | 35 | -969 |
| 1976-77 | - | 222 | 671 | 893 | 57 | - | - | 57 | -835 |
| 1977-78 | - | 222 | 671 | 893 | 57 | - | 8 | 65 | -828 |
| 1978-79 | - | 222 | 671 | 893 | 57 | - | 16 | 73 | -820 |
| 1979-80 | - | 222 | 671 | 893 | 57 | - | 23 | 80 | -813 |
| 1981-82 | - | 222 | 15,171 | 15,393 | 57 | - | 31 | 88 | -15,305 |
| 1982-83 | - | 222 | 15,171 | 15,393 | 57 | - | 39 | 96 | -15,297 |
| 1983-84 | - | " | 671 | 893 | " | 13,000 | " | 13,096 | 12,203 |
| 1984-85 | - | " | " | " | " | " | " | " | " |
| 1985-86 | - | " | " | " | " | " | " | " | " |
| 1986-87 | - | " | " | " | " | " | " | " | " |
| 1987-88 | - | " | " | " | " | " | " | " | " |
| 1988-89 | - | " | " | " | " | " | " | " | " |
| 1989-90 | - | " | " | " | " | " | " | " | " |
| 1990-91 | - | " | " | " | " | " | " | " | " |
| 1991-92 | - | | 671 | 893 | " | 13,000 | " | 13,096 | 12,203 |
| 1992-93 | - | " | 14,500 | 14,722 | " | 13,000 | " | 13,096 | -1,626 |
| 1993-94 | - | " | 14,500 | 14,722 | " | 13,000 | " | 26,096 | -1,626 |
| 1994-95 | - | " | - | 222 | " | 26,000 | " | 26,096 | 25,874 |
| 1995-96 | - | " | - | " | " | " | " | " | " |
| 1996-97 | - | " | - | " | " | " | " | " | " |
| 1997-98 | - | " | - | " | " | " | " | " | " |
| 1998-99 | - | " | - | " | " | " | " | " | " |
| 1999-2000 | - | " | - | " | " | " | " | " | " |

Table Eight presents the present value of costs, benefits and net benefits calculated using a range of discount rates.

Table Eight - Net Present Value for Stewart-Cassiar Highway - Costs and Benefits to the year 2000.

| Discount Rate. | Net Present Value |
|---|---|
| 3% | $51,141,000 |
| 6% | $ 8,678,000 |
| 9% | -$ 6,280,000 |

The analysis indicates that the project probably was a success. Although the net present value depends very strongly on the discount rate, it is likely a 6 percent or less rate of discount is reasonable. Inflation has been eliminated by the use of indexing so no inflation premium is necessary. Also, no risk premium should be applied.

As described above, only the major benefits were included while almost all the costs were included. Thus, the net benefits have probably been underestimated.

Very approximate methods of analysis have had to be used in this paper, but it is probably safe to say that the Stewart-Cassiar Highway was at least close to being a good investment. A more detailed study might be justified to verify and refine this conclusion.

Most of the benefits of the highway come from mines that would not have been developed in the absence of the increased exploration caused by the highway. These mines are in addition to those that would have been developed even if the highway had not been built. An effort to refine this paper should concentrate on a more accurate estimate of the size and timing of major mineral discoveries caused by the highway.

## Footnotes.

1. Vancouver Province, February 26, 1957, p.2.

2. Trevor Heaver, The Evaluation of Transportation Projects in Northern British Columbia , P.H.D.Thesis, p. 143.

3. British Columbia Department of Highways, Annual Report, Queens Printer, Victoria, B.C. years 1956-57 to 1973-74.

4. Loc. cit.

5. Christopher E. Graham, Mining Road Policy in British Columbia, unpublished paper, April 1977.

6. British Columbia Department of Mines and Mineral Resources, Annual Report, Queens Printer, Victoria, B.C. all years, 1954 to 1968; and Geology, Mining and Explorations in B.C., Queens Printer, Victoria, B.C., all years 1969 to 1974.

7. This was calculated by assuming that if the fully completed, full length highway resulted in a 20% increase in exploration, then the partially completed highway in each year would have a reduced effect in proportion to the fraction of highway completed.

8. Exploration activity for the years 1975 to 2000 was forecast by estimating that it would remain constant at the average level over the previous four years, 1971 to 1974. During this time the effects of the highway on exploration had reached its full amount and would not be expected to increase any more.

9. Baumol, "On the Social Rate of Discount."

10. Brian W. Mackenzie, "Economic Characteristics of Mineral Investment in Canada," CIM Bulletin, Sept. 1975, pp. 63-70.

11. Trevor Heaver, op. cit., p. 145.

12. British Columbia Forest Service, Annual Report, 1975. Queens Printer, Victoria, B.C., 1976, p.8.

13. British Columbia Forest Service, Annual Report - Statistics 1975, Queens Printer, Victoria, B.C., 1975, p.8.

14. B. C. Forest Service, op. cit., p. 15.

15. British Columbia Forest Service, Annual Report, all years 1970 to 1975, Queens Printer, Victoria, B.C.

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